2004 Program Evaluation

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Prepared By

Missouri Department of Natural Resources
Air and Land Protection Division
Air Pollution Control Program

Executive Summary

The St. Louis ozone nonattainment area, made up of the City of St. Louis and the counties of St. Louis, St. Charles, Jefferson, and Franklin, is currently classified by the EPA as a moderate ozone nonattainment area. By federal law, moderate ozone nonattainment areas must implement a basic vehicle emissions inspection and maintenance (I/M) program in any urbanized area with a 1990 Census-defined population of 200,000 or more.

The Gateway Clean Air Program was designed to replace the existing basic I/M program, called the BAR 90 I/M program, which had been established as part of the safety inspection requirement in the 1980s. In 1994, the Missouri General Assembly authorized the Missouri Department of Natural Resources to replace the decentralized basic vehicle emissions I/M program with a centralized enhanced vehicle emissions I/M program, called the Gateway Clean Air Program.

Two analyses are provided in this report. The first analysis method uses the MOBILE model to calculate the St. Louis enhanced I/M program composite emissions factors relative to the federal Basic I/M Performance Standard, which is Missouri's binding commitment to EPA, and the federal Enhanced I/M Performance Standard, which is Missouri's targeted goal. The second analysis method uses the Gateway Clean Air Program test data collected during the third and fourth years of operation, January 1, 2002, to December 31, 2003, to calculate the average reduction in composite emissions factors on a fleet wide basis. This report also establishes the actual emissions reductions achieved from the St. Louis enhanced I/M program using the I/M program data collected from the first through fourth years of operation, April 5, 2000, to December 31, 2003. If the results of both methods of analysis are complementary to each other and meet the goals stated, then the Gateway Clean Air Program will continue to be an EPA-approved I/M program.

The MOBILE model analysis method demonstrates that the St. Louis enhanced I/M program is more effective than the Basic I/M Performance Standard, and nearly as effective as the Enhanced I/M Performance Standard. The Gateway Clean Air Program test data analysis method demonstrates that the St. Louis enhanced I/M program is effectively reducing vehicle exhaust emissions and that the amended waiver requirements implemented as a result of the recommendation of the 2002 Program Evaluation Report are having a positive impact on the air quality benefits of the St. Louis enhanced I/M program.

Based upon these two analyses, the department recommends that EPA continue to designate the Gateway Clean Air Program as a federally-approved I/M program and find the I/M portion of the SIP approvable.

Acknowledgements

The Gateway Clean Air Program Test Data and Analysis section of this report was drafted by Peter M. McClintock, Ph.D., of Applied Analysis, in consultation with the department.

Abbreviations and Definitions

BAR 90 .....California Bureau of Automotive Repair test method implemented in 1990. Also the technical name for a single speed idle tailpipe emissions test used in basic I/M programs.

Basic I/M.....A vehicle inspection and maintenance program using a single speed idle tailpipe emissions test capable of measuring the concentration of vehicle emissions. Prior to the Gateway Clean Air Program, there was a basic I/M program in place.

CFR.....Code of Federal Regulations. The EPA publishes Title 40 Chapter I Subchapter C Part 51 Subpart S and Part 85 Subpart W, which establish the federal requirements for vehicle emissions I/M programs.

CO.....Carbon Monoxide, one of three pollutants measured during an IM240 test and one of two pollutants measured during a BAR 90 test

Enhanced I/M.....A vehicle inspection and maintenance program using a transient tailpipe emissions test capable of measuring the mass of vehicle emissions. The Gateway Clean Air Program uses the IM240 test.

EPA.....United States Environmental Protection Agency

ESP Missouri .....Environmental Systems Products Missouri, the private company awarded the Gateway Clean Air Program contract

gpm or g/mi.....grams per mile, a mass-based vehicle emissions unit of measurement

GVWR .....Gross Vehicle Weight Rating, specified by the manufacturer as the maximum design loaded weight

HC.....Hydrocarbons, one of three pollutants measured during an IM240 test and one of two pollutants measured during a BAR 90 test. In the case of vehicle emissions, the source of tailpipe and evaporative hydrocarbons is gasoline.

IM240.....A four-minute (240-second) tailpipe emissions test that simulates real world driving conditions using a dynamometer in order to more thoroughly evaluate a vehicle's on-road emissions

LDGT12.....MOBILE model version 6.2 Light Duty Gasoline-Powered Trucks with a GVWR less than 6,001 lbs.

LDGT34.....MOBILE model version 6.2 Light Duty Gasoline-Powered Trucks with a GVWR greater than 6,000 and less than 8,5001 lbs.

LDGV .....Light Duty Gasoline-Powered Vehicles with a GVWR less than 6,001 lbs.

lbs.....pounds

NO_x .....Oxides of Nitrogen, and one of three pollutants measured during an IM240 test

ppm .....parts per million, a concentration-based unit of measurement of vehicle emissions

RFG.....Reformulated Gasoline, a cleaner-burning formula of gasoline containing oxygenates. RFG is a federal requirement for ozone nonattainment areas designated as serious, severe, or extreme, and optional for nonattainment areas designated as moderate.

RFP .....Request for Proposals, a document released by the state's purchasing division for the purposes of securing the services of a private entity best able to provide the requested services to the state according to the terms of the contract

RSD.....Remote Sensing Device, the technology used to identify vehicles on the road that are running cleanly and do not need to visit an enhanced I/M test station

RSMo .....Revised Statutes of Missouri

SIP.....State Implementation Plan, a binding agreement between a state and the EPA to improve the air quality of a nonattainment area so that it can be redesignated as an attainment area

VMT.....Vehicle Miles Traveled

VOC .....Volatile Organic Compounds, any carbon-based compound that can evaporate into the ambient air. The HCs that make up gasoline are VOCs.

Outline

I. Introduction

The Gateway Clean Air Program was designed to replace the existing basic inspection and maintenance (I/M) program, called the BAR 90 I/M program, which had been established as part of the safety inspection requirement in the 1980s. This change was necessary for several reasons. The technology that was being used to test vehicle emissions, a single speed idle tailpipe test, had become outdated. And an audit conducted by the United States Environmental Protection Agency (EPA) Region VII found that up to 84% of the tests conducted by the decentralized private repair facilities were either fraudulent or done incorrectly.

A new program could alleviate these problems by requiring the use of state-of-the-art testing technology in centralized, test-only facilities. No repairs or diagnosis would be allowed by the testing facilities, thereby minimizing the occurrence of fraudulent or incorrect testing and maintaining program integrity. In 1994, pursuant to Senate Bill 590 being passed by the Missouri General Assembly and signed into law by Governor Mel Carnahan, the department was authorized to replace the decentralized basic vehicle emissions I/M program with a centralized enhanced vehicle emissions I/M program, called the Gateway Clean Air Program.

The enacted statutes, Sections 643.300 to 643.355, Revised Statutes of Missouri (RSMo), are known collectively as the Air Quality Attainment Act and are a direct result of the federal Clean Air Act Amendments of 1990. Missouri faced a 1996 deadline requiring the state to come into compliance with the ozone air quality standards of the Clean Air Act. The 1996 deadline was not met by the state, due in part to delays in the start of the Gateway Clean Air Program. Between 1994 and 1999, the St. Louis enhanced I/M legislation lay dormant due to lack of appropriations, legal challenges to the legislation, and state contracting challenges.

The first Request for Proposals (RFP) was released by the state in October 1997, but failed to receive any bids because the requirements of the RFP were not economically feasible. A second redesigned RFP was released by the state in October 1998, and two companies submitted bids. In February 1999, after both bids were evaluated, the state signed a contract with Environmental Systems Products (ESP) Missouri. With department oversight, ESP Missouri secured the property, buildings, test equipment and manpower necessary to begin the St. Louis enhanced I/M program on April 5, 2000, according to the terms of the contract.

This Gateway Clean Air Program Evaluation report will analyze whether:

1) the precursors of ground-level ozone, hydrocarbons (HC), also called volatile organic compounds (VOCs), carbon monoxide (CO), and oxides of nitrogen (NO_x), emitted by light duty gasoline-powered vehicles and trucks registered and driven primarily in the nonattainment area are being effectively reduced by the Gateway Clean Air Program; and

2) the St. Louis enhanced I/M program is exceeding the Missouri State Implementation Plan (SIP) commitment to EPA to meet the Basic I/M Performance Standard and is closer to the SIP goal to meet the Enhanced I/M Performance Standard.

II. Program Evaluation Parameters

A. Nonattainment Area I/M Program Requirements

The St. Louis ozone nonattainment area, made up of the City of St. Louis and the counties of St. Louis, St. Charles, Jefferson, and Franklin, is currently classified by the EPA as a moderate eight-hour ozone nonattainment area (Appendix A). According to Title 40 of the Code of Federal Regulations (CFR) Section 51.350 (a)(4), moderate ozone nonattainment areas must implement a basic vehicle emissions inspection and maintenance (I/M) program in any urbanized area with a 1990 Census-defined population of 200,000 or more[1].

The St. Louis ozone nonattainment area has complied with this federal requirement. The Gateway Clean Air Program is made up of two separate vehicle I/M programs. In St. Louis city and St. Louis, St. Charles and Jefferson Counties, a biennial enhanced I/M program is in operation according to the Air Quality Attainment Act state statues, 643.300-643.355, RSMo. In Franklin County, a biennial basic I/M program is in operation according to 307.366, RSMo. Because the 1990 Census-based population of Franklin County was less than 200,000, the basic I/M program that began in April 2000 according to state statute 307.366 RSMo is not evaluated by this program evaluation report.

Although the St. Louis ozone nonattainment area is only required by federal code to implement a basic vehicle emissions I/M program, the state of Missouri elected to implement an enhanced vehicle emissions I/M program in the majority of the nonattainment area for the reasons listed in the Introduction section of this report. Therefore, this report will evaluate the performance of the St. Louis enhanced I/M portion of the Gateway Clean Air Program relative to the Enhanced I/M Performance Standard established by federal code 40 CFR 51.351, which is Missouri's targeted goal, and the Basic I/M Performance Standard established by federal code 40 CFR 51.352, which is Missouri's binding commitment to EPA. Federal code 40 CFR 51.351 (f)(13) requires enhanced I/M programs to have emissions factors within 0.020 gram per mile (gpm) of the Enhanced I/M Performance Standard emissions factors. Federal code 40 CFR 51.352 (a)(12) requires Basic I/M programs to obtain the same or lower emissions factors as the Basic I/M Performance Standard emissions factors.

B. MOBILE Model Versions

Both federal codes 40 CFR 51.351 and 51.352 require states to use the most current version of the EPA mobile source emissions factor model, called MOBILE, to calculate the emissions factors achieved by a state's I/M program. When Missouri's I/M portion of the SIP was approved by EPA Region VII in May 2000, the most current version of the MOBILE model, version 5b, was used to model the composite emissions factors achieved by the St. Louis enhanced I/M program. However, the most current version of the MOBILE model is now version 6.2, made available on May 19, 2004. This report will evaluate the performance of the St. Louis enhanced I/M portion of the Gateway Clean Air Program using MOBILE model

[1] The EPA has not yet published a rule for the implementation of the eight-hour ozone standard in nonattainment areas. This rule may modify the requirements of 40 CFR 51.350. Until then, the current language of 40 CFR 51.350 is applicable.

version 6.2 to model the composite emissions factors achieved by the St. Louis enhanced I/M program.

C. Clean Screening

The Gateway Clean Air Program includes an EPA-recognized clean screening element to increase the overall motorist convenience of the program. By allowing clean-running vehicles that are identified on the road with remote sensing technology to skip a trip to an emissions test station, fewer vehicles have to visit a St. Louis enhanced I/M test station. However, a small percentage of the vehicles identified as running cleanly do have emissions that exceed the St. Louis enhanced I/M test standards. In other words, there is a small air quality benefit reduction for incorporating this motorist convenience element into an I/M program.

Version 6.2 of the MOBILE model is not yet capable of modeling this air quality benefit reduction. Therefore, the small air quality benefit reduction of the clean screening element of the Gateway Clean Air Program is not modeled.

D. Final Standards

The St. Louis enhanced I/M program was designed to comply with the federal guidelines established in the August 1998 IM240 & Evap Technical Guidance document, which has since been revised by EPA in April 2000. To avoid overwhelming the local vehicle repair industry, federal code 40 CFR 85.2205 (a) of this guidance recommends the use of Start-up Standards during the first two years of enhanced I/M program operation, followed by the use of Final Standards. These Start-up Standards allowed the vehicle repair industry to develop their skills and concentrate their efforts during the first two years on fixing the vehicles with the worst emissions before Final Standards are implemented. In 2002 and 2003, the Gateway Clean Air Program used these IM240 Final Standards. Therefore, the MOBILE model analysis will focus on the impact that these Final Standards have had on IM240-tested vehicles.

E. Purge Testing

Missouri's I/M portion of the SIP includes a commitment to conduct purge testing, because purge testing is a part of the Enhanced I/M Performance Standard described in federal code 40 CFR 51.351. Because a non-intrusive purge test has not yet been approved by the EPA, Missouri did not claim any purge testing credit in the EPA-approved I/M portion of the SIP. As a result of EPA removing the purge test standards, procedures, specifications, and quality control practices from the April 2000 revision of the IM240 and Evap Technical Guidance, the capability of modeling the air quality benefit of purge testing was also removed from MOBILE model version 6.2. Therefore, the MOBILE model version 6.2 Enhanced I/M Performance Standard does not include the theoretical air quality benefit of purge testing.

F. Refueling Emissions

The St. Louis ozone nonattainment area does employ two other VOC control strategies that can be modeled using the MOBILE model. The first VOC control strategy is the recovery of

gasoline vapors at the point of distribution to gasoline-powered vehicles. This Stage II Vapor Recovery program has been in effect in the St. Louis ozone nonattainment area since 1989 and has been a substantial piece of the overall planned reductions included in the Missouri SIP. However, because the Gateway Clean Air Program does not directly impact these refueling emissions, and this report is focused only on the air quality benefit of the St. Louis enhanced I/M program, the contribution of the Stage II Vapor Recovery program to VOC emissions reductions has not been modeled.

G. Reformulated Gasoline

The second VOC control strategy is the federal reformulated gasoline (RFG) program. The RFG program has been in effect in the St. Louis ozone nonattainment area since the state chose to opt into this federal program in May 1999. RFG has also been a substantial piece of the overall planned reductions included in the Missouri SIP. Because RFG burns more cleanly than conventional gasoline in all gasoline-powered vehicles, RFG does reduce the emissions levels of vehicles tested by the Gateway Clean Air Program. Therefore, the contribution of RFG to VOC emissions reductions has been modeled.

H. BAR 90 I/M Program Comparison

The St. Louis enhanced I/M program area transitioned from a decentralized BAR 90 I/M program to the Gateway Clean Air Program in January 2000. However, if the Air Quality Attainment Act had not been passed and the Gateway Clean Air Program had not been implemented, the BAR 90 I/M program would still be in place. This report compares the modeled emissions factors achieved by such a scenario with the emissions levels achieved by the Gateway Clean Air Program in order to demonstrate that Missouri's air quality has benefited due to the transition from the BAR 90 I/M program to the Gateway Clean Air Program.

I. MOBILE Model Month of Evaluation

According to 40 CFR 51.353 (c)(1), states must report the results of their program evaluation to the EPA on a biennial basis, starting two years after the initial start of mandatory testing. Because the Gateway Clean Air Program began mandatory testing in 2000, and the levels of ozone in the St. Louis nonattainment area have only exceeded the Clean Air Act health-based standards in the summer months, the composite emissions factors calculated with MOBILE model version 6.2 are for the calendar year 2004 and the month of July.

J. Evaluation of St. Louis Enhanced I/M Program Data

Federal code 40 CFR 51.353 (c)(2) requires states to establish actual emissions reductions achieved from I/M programs. Federal code 40 CFR 51.353 (c)(3) requires states to use, at a minimum, a representative, random sample of at least 0.1 percent of the vehicles and subject these vehicles to a mass emissions test using the transient test method, commonly referred to as the IM240 test. 40 CFR 51.353 (c)(4) requires states to use this small sample of IM240 test data to calculate local fleet emissions factors in order to assess the effectiveness of the I/M program, and to determine if the relevant performance standard is being met. Because the St. Louis

enhanced I/M program uses the IM240 test on all 1981 and newer model year vehicles, this report analyzes all available IM240 data. All remaining data from other vehicle emissions test methods has been converted into IM240-equivalent data, so that the actual emissions reductions from each test method can be aggregated into initial and final mass-based fleet emissions factors.

K. MOBILE Model and Enhanced I/M Program Data Comparison

The MOBILE model and the Gateway Clean Air Program test data analyses provided in this report are not directly comparable with each other. The MOBILE model analysis is static in time, meaning that all of the MOBILE model scenarios are for one time period. The purpose of this static analysis is to eliminate the impact that unknown variables might have on one or more scenarios. Because of the static nature of MOBILE modeling, it cannot provide a time-lapsed average emissions reduction analysis. On the other hand, the St. Louis enhanced I/M program data analysis is dynamic in time. By considering every initial emissions inspection and every final emissions inspection within the first two years of Gateway Clean Air Program operation, a time-lapsed average emissions reduction analysis can be conducted.

Additionally, the MOBILE model is designed to calculate the emissions factors of a fleet of vehicles using multiple assumptions and inputs, only some of which can be controlled by the model inputs, to estimate the impact of all vehicles operating in the affected area through a wide range of operating conditions. The Gateway Clean Air Program test data is based on a limited set of vehicle operating conditions, defined by the test method parameters, applied to a limited set of vehicles. So while both analyses are provided in this report, the results of each analysis method must be considered independently.

If the results of both methods of analysis are complementary to each other and meet the goals established in the Introduction section, then the Gateway Clean Air Program will continue to be an EPA-approved I/M program.

III. MOBILE Model Data and Analysis

A. MOBILE Model Inputs

The MOBILE model version 6.2 input files describe five different scenarios (Appendix B).

The first input scenario, NoIM04.in, models the July 2004 average fleet composite emissions factors assuming that there was no I/M program in operation in the St. Louis ozone nonattainment area. The only VOC emissions control strategy in effect for this scenario is RFG. The following inputs were used to model the No I/M case:

Calendar Year: 2004
Month: 7 (July)

The second input scenario, Bar9004.in, model the July 2004 average fleet composite emissions factors assuming that RFG and the BAR 90 I/M program described in 307.366, RSMo were in effect, and that the St. Louis enhanced I/M program described in 643.300-643.355, RSMo was not in effect. The following inputs were used to model the BAR 90 I/M program case:

Start Year: 1990[2]
Inspection Frequency: Biennial[3]
Inspection Type: Test and Repair-Computerized (TRC)
Emissions Test Type: Single Speed Idle
First Model Year Tested: 1971[4]
Last Model Year Tested: 2004
Grace Period: 2 years[5]
Vehicle Types Tested: LDGV, LDGT12, LDGT34
Stringency Rate: 17%[6]
Compliance Rate: 96%
Pre-1981 Model Year Waiver Rate: 9.8%[6]
1981+ Model Year Waiver Rate: 6.0%[7]
Effectiveness: HC – 50%; CO – 50%; NO_x – 0%[8]

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[2] Although there was a basic I/M program in place prior to 1990, it was a paper-based program (Test and Repair-Manual), which the MOBILE model considers even less effective than a computer-based (TRC) program. Therefore, 1990 was selected as the start year.

[3] 307.366, RSMo was amended to change the basic emission inspection frequency from an annual to a biennial frequency, effective August 28, 2003.

[4] Set by Missouri statute 307.366, RSMo. Due to a statute change, beginning August 28, 2004, the Gateway Clean Air Program exempts vehicles greater than 26 years old from the emissions inspection requirement. Because this change took place after the month of evaluation, July 2004, the impact of this change was not analyzed. The next Program Evaluation Report will address this change.

[5] The first two model years are statutorily exempt from the emission inspection requirement.

[6] This value represents the 1971-1980 model year failure rate based on data from the third and fourth years of Gateway Clean Air Program.

[7] The waiver rates of 9.8% and 6% come from the third and fourth years of Gateway Clean Air Program test data in Franklin County, the basic I/M area.

[8] The MOBILE model assumes that test and repair I/M programs are only half as effective as test only I/M programs, unless data can support a higher effectiveness. Given the EPA's audit findings described in the Introduction section, the effectiveness of the BAR 90 I/M program was not assumed to have more than 50% of the effectiveness of a test-only I/M program. In addition, the BAR 90 I/M program did not test vehicles for NO_x emissions, so NO_x emission reductions are not modeled.

Calendar Year: 2004
Month: 7 (July)

The third input scenario, BPerfStd.in, models the July 2004 average fleet composite emissions factors assuming that RFG and the Basic I/M Performance Standard, described in federal code 40 CFR 51.352, were in effect. This Basic I/M Performance Standard is the standard against which the EPA is required to measure the Gateway Clean Air Program. The following inputs were used to model the Basic I/M Performance Standard case:

Start Year: 1983
Inspection Frequency: Annual
Inspection Type: Test Only (T/O)
Emissions Test Type: Single Speed Idle
First Model Year Tested: 1968
Last Model Year Tested: 2004
Vehicle Types Tested: LDGV only
Stringency Rate: 20%
Compliance Rate: 100%
Pre-1981 Model Year Waiver Rate: 0%
1981+ Model Year Waiver Rate: 0%
No Repair Technician Training Credit
Calendar Year: 2004
Month: 7 (July)

The fourth input scenario, GCAP04.in, models the July 2004 average fleet composite emissions factors of the Gateway Clean Air Program. The following inputs were used to model the St. Louis enhanced I/M portion of the Gateway Clean Air Program case:

Start Year: 1990[9]
Inspection Frequency: Biennial
Inspection Type: Test Only (T/O)
Emissions Test Types And Model Years: Single Speed Idle for 1971-1980 model years, IM240 with final cutpoints for 1981-2004, Gas Cap for 1981-2004 model years
Vehicle Types Tested: LDGV, LDGT12, LDGT34
Stringency Rate: 17%
Compliance Rate: 96%
Pre-1981 Model Year Single Speed Idle Waiver Rate: 5%[9]
1981+ Model Year IM240 Waiver Rate: 5%[10]
Pre-1981 and 1981+ Model Year Gas Cap Waiver Rates: 0%
Calendar Year: 2004
Month: 7 (July)

[9] Although the MOBILE model doesn't account for previous years' tailpipe emission testing, it does give some credit for the anti-tampering effect of previous I/M programs. Therefore, the start year of the test-and-repair basic I/M program, 1990, is used instead of the start year of the test-only enhanced I/M program, 2000.

[10] The waiver rates of 5% comes from the fourth year of Gateway Clean Air Program test data. This waiver rate represents an 80% reduction in the waiver rate from the third year of Gateway Clean Air Program test data.

The fifth input scenario, EPerfStd.in, models the July 2004 average fleet composite emissions factors of the Enhanced I/M Performance Standard, using IM240 Final Standards, described in federal code 40 CFR 51.351. This Enhanced I/M Performance Standard is the standard that the St. Louis enhanced I/M program was designed to and is striving to meet. The following inputs were used to model the Enhanced I/M Performance Standard case:

Anti-Tampering Testing: 1983 Start, 1968-2004 Model Years, Test Only, Annual, 96% Compliance Rate, Visual Inspection of Catalytic Converter, Fuel Inlet Restrictor, Exhaust Gas Recirculation system, Evaporative system, Positive Crankcase Ventilation valve, and Gas Cap
Start Year: 1983
Inspection Frequency: Annual
Inspection Type: Test Only (T/O)
Emissions Test Types And Model Years: Single Speed Idle for 1968-1980 model years, Two Speed Idle for 1981-1985 model years, IM240 with final cutpoints for 1986-2004, Full Pressure and Gas Cap for 1983-2004 model years
Vehicle Types Tested: LDGV, LDGT12, LDGT34
Stringency Rate: 20%
Compliance Rate: 96%
Pre-1981 Model Year Tailpipe Test Waiver Rate: 3%
1981+ Model Year Tailpipe Test Waiver Rate: 3%
Pre-1981 and 1981+ Model Year Evaporative Test Waiver Rate: 0%
Calendar Year: 2004
Month: 7 (July)

B. MOBILE Model Outputs

The MOBILE model version 6.2 output files (Appendix C) provide local fleet composite emissions factors for the five input scenarios described above.

C. MOBILE Model Analysis

The MOBILE model calculates emissions factors for each vehicle type that is on the road, including light duty gasoline-powered vehicles and trucks, heavy duty gasoline-powered trucks, light and heavy duty diesel-powered vehicles and trucks, and motorcycles. However, the St. Louis enhanced I/M program impacts only light duty gasoline-powered vehicles and light duty gasoline-powered trucks with a gross vehicle weight rating under 8,501 lbs.[11] Therefore, the comparisons of the five scenarios consider only the vehicle miles traveled (VMT)-weighted average of the calculated LDGV and LDGT1 through LDGT4 emissions factors.

The St. Louis enhanced I/M program reduces three types of tailpipe exhaust pollution: hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO_x). The St. Louis enhanced I/M program also reduces one type of non-exhaust pollution: evaporated hydrocarbons (HC) trapped within the fuel system.

[11] These light duty gasoline-powered vehicles and trucks make up 86.8% of the MOBILE model version 6.2 vehicle miles traveled in the enhanced I/M area.

The VMT-weighted average of the calculated composite exhaust emissions factors are listed in Table 3.1 for each MOBILE model version 6.2 scenario. The VMT-weighted average of the calculated composite non-exhaust emissions factors are listed in Table 3.2 for each MOBILE model version 6.2 scenario[12]. The results of Tables 3.1 and 3.2 are graphed in Figure 3.1 and 3.2, respectively, below.

Table 3.1 – MOBILE 6.2 Composite Exhaust Emissions Factors

Scenario Description	**Exhaust HC**	**Exhaust CO**	**Exhaust NO_x**
No I/M	0.669	13.01	1.120
BAR 90 I/M	0.598	12.40	1.103
Basic I/M Performance Standard	0.625	12.37	1.112
Gateway Clean Air Program	0.533	10.89	0.995
Enhanced I/M Performance Standard	0.510	10.87	0.983

Table 3.2 – MOBILE 6.2 Composite Non-Exhaust Emissions Factors

Scenario Description	**Non-Exhaust HC**
No I/M	0.533
BAR 90 I/M	0.533
Basic I/M Performance Standard	0.533
Gateway Clean Air Program	0.521
Enhanced I/M Performance Standard	0.510

[12] MOBILE model version 6.2 is not yet capable of modeling the impact of clean screening on emission factors. Therefore, the Gateway Clean Air Program emission factors may, in fact, be larger than those stated.

Figure 3.1 – MOBILE 6.2 Composite Exhaust Emissions Factors

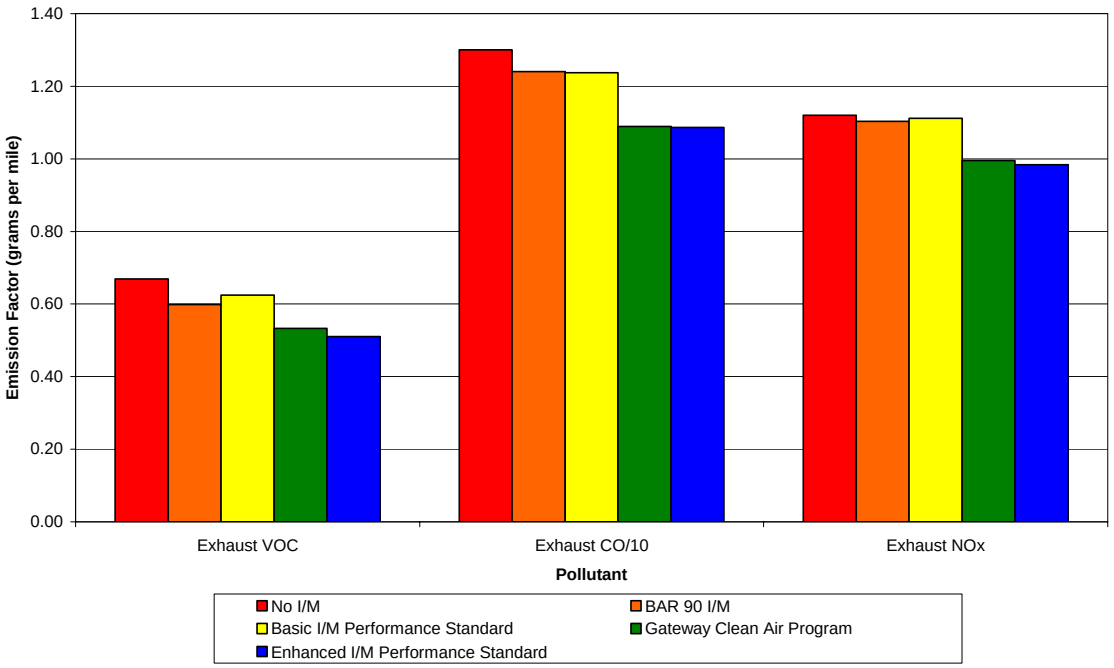
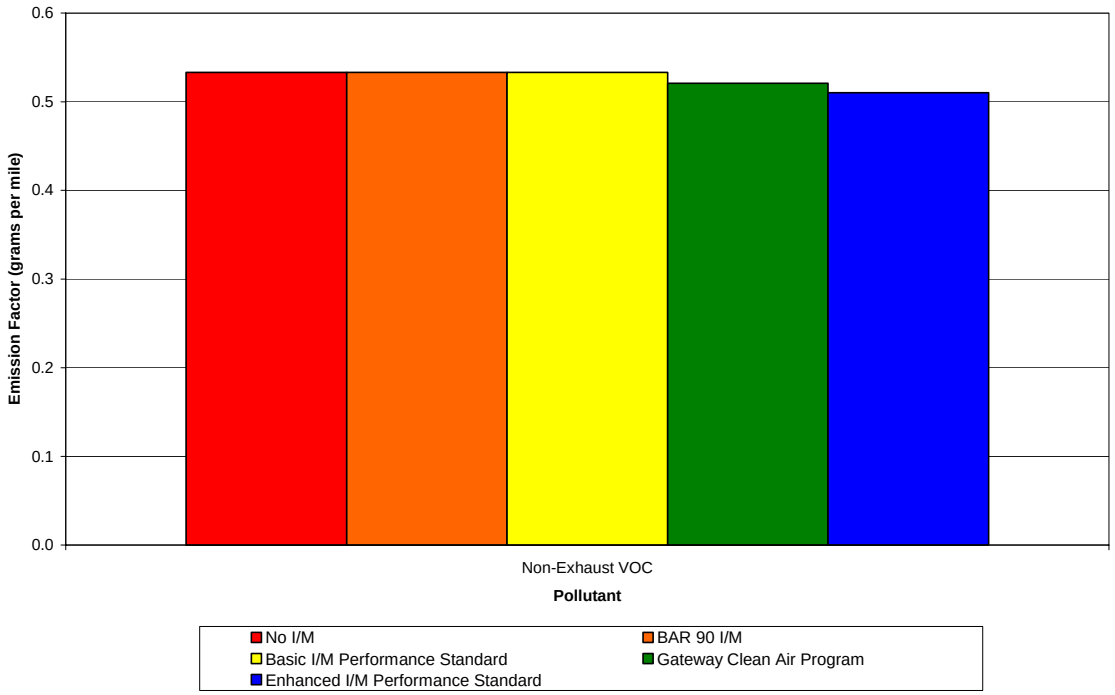


Figure 3.2 – MOBILE 6.2 Composite Non-Exhaust Emissions Factors



Based upon MOBILE model version 6.2 modeling, the Gateway Clean Air Program scenario composite emissions factors (the green bars in Figures 3.1 and 3.2) are less than the No I/M scenario composite emissions factors (the red bars in Figures 3.1 and 3.2) and the BAR 90 I/M scenario composite emissions factors (the orange bars in Figures 3.1 and 3.2) for Exhaust HC, CO, and NO_x and Non-Exhaust HC. Therefore, the Gateway Clean Air Program is more successful at reducing the contribution that light duty gasoline-powered vehicles and trucks make to St. Louis area ozone formation when compared with the scenarios where no vehicle emissions I/M program or the BAR 90 I/M program is in place.

Based upon MOBILE model version 6.2 modeling, the Gateway Clean Air Program scenario composite emissions factors (the green bars in Figures 3.1 and 3.2) are less than the Basic I/M Performance Standard scenario composite emissions factors (the yellow bars in Figures 3.1 and 3.2) for Exhaust HC, CO, and NO_x and Non-Exhaust HC. Therefore, the Gateway Clean Air Program has met the requirement in federal code 40 CFR 51.352 (a)(12) and is fulfilling Missouri's binding commitment with the EPA.

Based upon MOBILE model version 6.2 modeling, the Gateway Clean Air Program scenario composite emissions factors (the green bars in Figures 3.1 and 3.2) are slightly greater than the Enhanced I/M Performance Standard scenario composite emissions factors (the blue bars in Figures 3.1 and 3.2) for Exhaust HC, CO, and NO_x and Non-Exhaust HC. The Gateway Clean Air Program is 0.023 gpm above the Exhaust HC Enhanced I/M Performance Standard, 0.029 gpm above the Exhaust CO Enhanced I/M Performance Standard, 0.012 gpm above the Exhaust NO_x Enhanced I/M Performance Standard, and 0.011 gpm above the Non-Exhaust HC Enhanced I/M Performance Standard.

Because all of the Gateway Clean Air Program emissions factors are not within the 0.020 gpm tolerance allowed by the Enhanced I/M Performance Standard, the Gateway Clean Air Program has not yet achieved the requirement in federal code 40 CFR 51.351. However, the Gateway Clean Air Program has achieved the Enhanced I/M Performance Standard for NO_x and Non-Exhaust HC emissions, and is only 0.003 and 0.009 gpm, respectively, away from achieving the Enhanced I/M Performance Standards for Exhaust HC and CO emissions.

There are several reasons that the MOBLE model analysis does not show the Gateway Clean Air Program achieving the Enhanced I/M Performance Standard, Missouri's targeted goal:

1. The Enhanced I/M Performance Standard models an annual I/M program requirement. Annual I/M programs are more effective but less convenient than the Gateway Clean Air Program's biennial I/M program requirement.
2. The Enhanced I/M Performance Standard models an I/M program that tests 1968 and newer model year vehicles. The Gateway Clean Air Program tests 1971 and newer model year vehicles, excluding the first two model years[13].

[13] Due to a statute change, beginning August 28, 2004, the Gateway Clean Air Program exempts vehicles greater than 26 years old from the emissions inspection requirement. Because this change took place after the month of evaluation, July 2004, the impact of this change was not analyzed. The next Program Evaluation Report will address this change.

3. The Enhanced I/M Performance Standard includes full evaporative system pressure testing, which is an invasive test that takes a longer amount of time. The Gateway Clean Air Program conducts only the gas cap test portion of the full evaporative system pressure test, which is not invasive and takes a shorter amount of time.
4. The Enhanced I/M Performance Standard models an anti-tampering I/M program element conducted on every vehicle. The Gateway Clean Air Program only conducts an anti-tampering I/M inspection on those vehicles that fail a tailpipe or gas cap test.

The Gateway Clean Air Program is designed to maximize air quality benefits and motorist convenience. The Gateway Clean Air Program has endeavored to find the right balance between these two goals. Because the Gateway Clean Air Program composite emissions factors are less than the Basic I/M Performance Standard composite emissions factors, the standard by which EPA is measuring the Gateway Clean Air Program, the motorist convenience elements that are keeping the Gateway Clean Air Program from attaining the Enhanced I/M Performance Standard should not be abandoned. While this report makes no recommendation to increase the air quality benefit of the St. Louis enhanced I/M program, the department's Air Pollution Control Program will continue to monitor the air quality benefit and motorist convenience factors to ensure that the current balance is maintained.

D. St. Louis Enhanced I/M Emissions Reductions

The MOBILE model analysis provided in this section is not designed to quantify the emissions reductions achieved by the Gateway Clean Air Program. The static analysis is designed to quantify the relative effectiveness of five different I/M scenarios, ranging from no I/M program to the Enhanced I/M Performance Standard. Only by analyzing the St. Louis enhanced I/M program data can the Gateway Clean Air Program emissions reductions be quantified. This analysis is provided in the next section.

IV. Gateway Clean Air Program Test Data and Analysis[14]

The Gateway Clean Air Program uses four test types at the St. Louis enhanced I/M test stations:

- OBD – Applicable to most 1996 and newer vehicles, starting in 2003
- IM240 – Transient test, applicable to 1981 and newer model year vehicles
- TSI – Two Speed Idle test, applicable to 1981 and newer model year vehicles that cannot be safely tested with an IM240 test
- SSI – Single Speed Idle test, applicable to 1971 to 1980 model year vehicles

Starting in 2003, 1996 and newer vehicles with on-board diagnostic (OBD) systems could pass inspection without a tailpipe emissions test provided their OBD systems indicated the emissions controls were functioning correctly. If the OBD system on a vehicle indicated a possible problem, or had system monitors that were unset indicating the system had not fully completed an evaluation of the monitored emissions control devices, then the vehicle was inspected using the appropriate tailpipe test as before.

Vehicles may fast-pass the IM240 test after 30 seconds. All vehicles that fail the IM240 test run the full 240 seconds of the test. Those failing within two times the IM240 test standard are given a second-chance IM240 test.

This Program Evaluation report analyzes the third and fourth years of operation of the Gateway Clean Air Program, from January 1, 2002, to December 31, 2003. Data used in the analyses of this report are primarily drawn from the I/M test database maintained on the ESP Missouri host computer system. The Vehicle Test Record table within the I/M test database contains emissions test result information for each type of test for all vehicles inspected.

A. Methodology Used to Determine Tailpipe Emissions Factors

Using the actual measurements for each vehicle inspected, the following steps are used to estimate local fleet tailpipe emissions factors:

1. Determine the initial and final tailpipe emissions for each vehicle tested
2. Convert TSI and SSI test results to IM240-equivalent gpm emissions factors

Tailpipe emissions test measurements are not directly available for two groups of vehicles:

1. Vehicles that are RapidScreened
2. Vehicles that pass an OBD inspection

RapidScreened and OBD-passed vehicles do not have reductions in emissions that can be directly determined, although vehicles may have been better maintained in anticipation of the emissions inspection requirement. However, it is necessary to determine their emissions in order to have a complete picture of the light-duty gasoline vehicle and truck emissions inventory.

[14] This section of this report was drafted by Peter M. McClintock, Ph.D., of Applied Analysis, in consultation with the department.

In the case of RapidScreen vehicles a random sample of vehicles eligible for RapidScreen receive inspections at stations. The emissions of the RapidScreen vehicles are calculated from the station test results of the random sample.

The emissions of vehicles passing an OBD inspection are assumed to be the same as vehicles of the same model year that initially passed an IM240 test. Note that during the 2002-2003 biennium, the majority of such IM240 tests were performed in 2002. In future years, the emissions of these vehicles will likely be assessed using on-road emissions measurements available from the RapidScreen program or a random sample of tailpipe testing.

B. Categorizing Initial and Final Tailpipe Emissions

In order to evaluate the Gateway Clean Air Program emissions factors, vehicle test results were sorted by VIN, test date and time. Vehicles were then further classified into one of four categories, Passed, Repaired, Unresolved, or Waived, based on their first and last test result during the period of evaluation. Interim results were ignored. In the list below, the first and last results are indicated in parenthesis, where "P" is pass, "F" is fail, "W" is waiver and "Null" indicates that there was only a single test result for a particular vehicle. The expected combinations that apply to the vast majority of vehicles are in bold.

1. Passed – Passed initial test (**P/Null**, P/P, P/F, P/W)
2. Repaired – Failed and successfully repaired (**F/P**)
3. Unresolved – Failed unresolved (**F/Null**, **F/F**)
4. Waived – Failed and wavered (**F/W**)

The difference between the initial and final tests is used to determine the percentage of tailpipe emissions reduction of each group. For vehicles with only one test, the final result is the same as the initial result.

C. Adjustment of IM240 Fast-Pass Results

To allow for comparison of emissions of vehicles tested over different durations of the IM240 test cycle, the emissions results for vehicles that fast-pass the IM240 inspection must be extrapolated. During the IM240 test, the highest gram per mile values occur at second 30 and decrease as the test continues. Gram per mile emissions are highest at the beginning of the test for two reasons. First, some vehicles may not have been properly preconditioned prior to testing, so that their engines and catalytic converters are not fully warmed up, resulting in higher emissions at the start of the test. The emissions of these vehicles decrease once the engine and converter are hot. Second, the first part of the IM240 test simulates urban driving, while the second part simulates highway driving. The mass of tailpipe emissions per mile are higher over the first part of the IM240 cycle.

Several methods have been developed for estimating full test values from fast-pass IM240 test results. The Lawrence Berkeley Livermore Laboratory (LBNL) method developed by Tom

Wenzel[15] has been used here. The LBNL method is based on a sample of second-by-second emissions of 4,000 vehicles given the full IM240 in Arizona in 1992. The gpm emissions were calculated for each vehicle for each second of the test, by dividing the cumulative grams of emissions over the cumulative distance driven at each second of the test. The gpm emissions for each second were then averaged over the entire sample. The ratio is calculated of the emissions at each second to the emissions for the full IM240, for each pollutant for each vehicle. The adjustment factors are as high as three for vehicles passed immediately after 30 seconds. Each of the adjustment factor curves reaches unity at second 240. The adjustments are greater for HC and CO emissions than for NO_x emissions. The simplicity of the LBNL method allows it to be applied to stored IM240 test results.

The conversion of fast-pass results to a full 240 second test result has considerable potential for introducing error into the estimated emissions inventory of vehicles that fast-pass their emissions test because the LBNL method did not separate passing and failing vehicles in determining the appropriate multiplier. If passing vehicles perform relatively better on the second part of the IM240 than failing vehicles, which is likely, then the method is likely to overestimate the emissions of clean vehicles. Failing vehicles all receive at least one full 240-second test and many receive two. Therefore, their initial failing emissions do not need to be extrapolated and are less subject to error.

The effect of overestimating the emissions of clean vehicles is to overestimate the total fleet emissions and consequently to underestimate the percentage of reductions. In future years, a random sample of full 240-second test results on vehicles that fast-pass may be used to verify and improve the accuracy of the fast-pass to 240-second test projection.

D. Vehicles with Waivers

The inspection records for the waiver transaction do not contain tailpipe emissions test results. The final emissions data used for these vehicles are, therefore, the results from the last tailpipe emissions inspection preceding the waiver. The reductions shown for these vehicles may not always reflect the final repairs made to the vehicle after it is waived and may therefore understate the Gateway Clean Air Program emissions reductions.

E. First and Final Emissions Results

When vehicles fail their initial inspection, they must obtain a repair and return for re-inspection. This process is normally completed in 30 days, but can take longer. To avoid overstating the number of vehicles that have not completed the repair process, the initial and final matching process selects initial tests conducted from January 1, 2002, through December 31, 2003, and final tests conducted from January 1, 2002, through February 28, 2004. This allows 60 days for vehicles to have completed their test and repair cycle, which should be the majority of those that will complete the cycle.

[15] Wenzel, T. "Converting Fast Pass/Fast Fail Emissions Results to Full IM240 Equivalents", LBNL Report, August 2000.

A number of failing vehicles do not complete the repair-reinspection process. In most cases, these vehicles are either scrapped or removed from the nonattainment area, which does reduce emissions. Surveys in Arizona[16] and Colorado[17] have found that some vehicles continue to operate in the area in violation of the program rules, either with expired license plates or with stolen license plates or license plate stickers. In this report, it is assumed that two-thirds of these unresolved vehicles leave the area and one-third continue to operate illegally in the area, which accounts for an assumed 67% reduction in emissions from unresolved vehicles.

Table 4.1 contains an example of the initial and final tailpipe results for 1981 to 1984 passenger vehicles inspected using the IM240 test. The table shows the average initial and average final emissions for each group of vehicles together with the percentage reduction.

For example, of the 1,200 1981 model year passenger vehicles tested using the IM240 transient test, 27.9% of 1981 model year vehicles initially failed inspection and were repaired (Passed) with over 80% reductions in HC and CO and a 50% reduction in NO_x. Another 23.0% of 1981 model year vehicles failed their initial inspection and had not successfully passed a retest by February 28, 2004 (Unresolved). Reductions from these vehicles are estimated to be approximately 67% for HC, CO and NO_x, because two-thirds are assumed to have left the area and the remaining one-third have modest reductions. Finally, 8.3% of 1981 model year vehicles received a waiver (Waived), and the measured reductions prior to the waiver were 31.4% HC, 21.4% CO and 35.5% NO_x. In aggregate, including vehicles that passed their initial inspection, 1981 passenger vehicle emissions were reduced 60.3% for HC, 58.4% for CO and 38.5% for NO_x.

Complete tables by test type, model year and vehicle type are provided in Appendix D.

[16] Wenzel, T. "Evaluation of Arizona's Enhanced I/M Program." Presented at the 9th CRC On-Road Vehicle Emissions Workshop. April 1999.

[17] McClintock, P. "The Denver Remote Sensing Clean Screening Pilot", ESP report for the Colorado Department of Health, December 1999.

Table 4.1 Transient Test Emissions Reductions for 1981-1984 Passenger Vehicles

Appendix D1 IM240 Test Emissions Reductions

Unresolved fails remaining in area 33%

Model Year/Type	First Result	Last Result	Vehicles		Initial HC	Initial CO	Initial NOX	Final HC	Final CO	Final NOX	Reduction % HC	Reduction % CO	Reduction % NOX
1981	Pass	-	490		0.41	6.10	1.62	0.41	6.10	1.62	0.0%	0.0%	0.0%
P	Fail	Pass	335	27.9%	2.33	35.23	2.90	0.43	5.83	1.46	81.4%	83.5%	49.7%
	Fail	Unresolv.	276	23.0%	4.43	62.09	2.53	1.42	21.05	0.82	67.9%	66.1%	67.6%
	Fail	Waiver	99	8.3%	4.71	69.18	2.76	3.23	54.41	1.78	31.4%	21.4%	35.5%
Total	Fail%		1,200	59.2%	2.23	32.31	2.28	0.88	13.45	1.40	60.3%	58.4%	38.5%
1982	Pass	-	737		0.47	6.43	1.82	0.47	6.43	1.82	0.0%	0.0%	0.0%
P	Fail	Pass	302	18.3%	2.20	29.58	3.01	0.45	5.62	1.80	79.4%	81.0%	40.1%
	Fail	Unresolv.	272	16.5%	3.63	56.48	2.70	1.18	17.45	0.92	67.4%	69.1%	66.0%
	Fail	Waiver	336	20.4%	3.38	53.35	2.91	2.99	47.65	2.67	11.6%	10.7%	8.5%
Total	Fail%		1,647	55.3%	1.90	28.51	2.41	1.10	16.51	1.84	42.3%	42.1%	23.5%
1983	Pass	-	1,163		0.43	4.76	1.77	0.43	4.76	1.77	0.0%	0.0%	0.0%
P	Fail	Pass	682	26.3%	1.80	25.56	3.02	0.42	4.59	1.63	76.8%	82.0%	46.1%
	Fail	Unresolv.	550	21.2%	3.57	52.62	2.69	1.23	17.56	0.86	65.6%	66.6%	67.9%
	Fail	Waiver	203	7.8%	3.47	57.54	2.79	2.68	40.34	2.33	22.8%	29.9%	16.5%
Total	Fail%		2,598	55.2%	1.69	24.48	2.37	0.77	10.21	1.58	54.5%	58.3%	33.2%
1984	Pass	-	2,773		0.47	5.17	1.77	0.47	5.17	1.77	0.0%	0.0%	0.0%
P	Fail	Pass	1,091	19.4%	1.84	25.47	2.75	0.44	4.43	1.66	76.0%	82.6%	39.7%
	Fail	Unresolv.	802	14.3%	3.32	49.51	2.80	1.11	16.39	0.92	66.5%	66.9%	67.3%
	Fail	Waiver	953	17.0%	3.12	48.40	2.98	2.75	43.91	2.70	11.8%	9.3%	9.3%
Total	Fail%		5,619	50.6%	1.59	22.77	2.31	0.95	13.20	1.78	40.7%	42.0%	22.9%

F. Convert Idle Test Tailpipe Concentrations to IM240-Equivalent Grams per Mile

Remote sensing measurements are used to correlate idle test values to IM240-equivalent values. This is done in three steps:

1. Compare Idle test results of vehicles to their on-road remote sensing values;
2. Compare on-road remote sensing emissions of vehicles to their IM240 test emissions;
3. Combine the results from 1. and 2. above to convert Idle test values to equivalent IM240 test values.

1. Idle Test Results vs. Remote Sensing Values

Figure 4.1 plots the on-road emissions measurements of vehicles against their St. Louis enhanced idle test results. Each point shows the average emissions of one model year of vehicles. The resulting emissions trend line is not linear and has been fitted to a power equation. The correlation equations for HC and CO are shown in Table 4.2. There is no correlation equation for NO_x, because the idle test does not measure NO_x emissions.

Figure 4.1 St. Louis Enhanced Idle vs. Remote Sensing HC

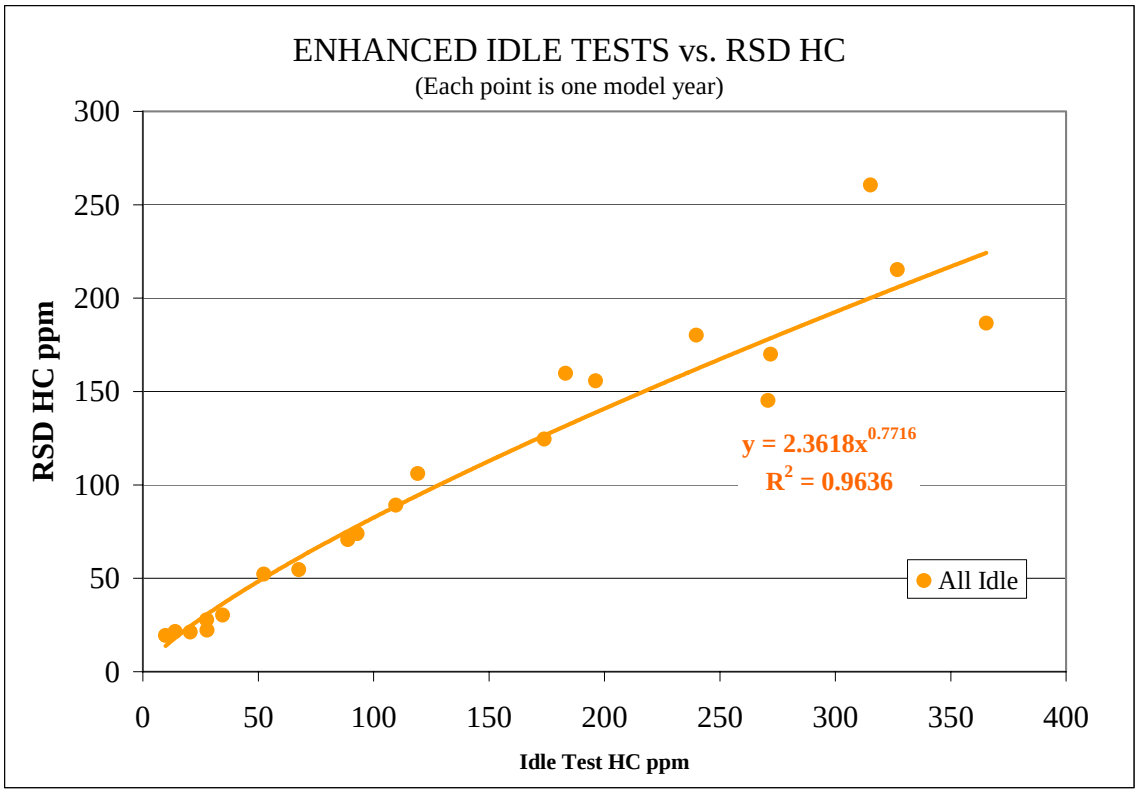


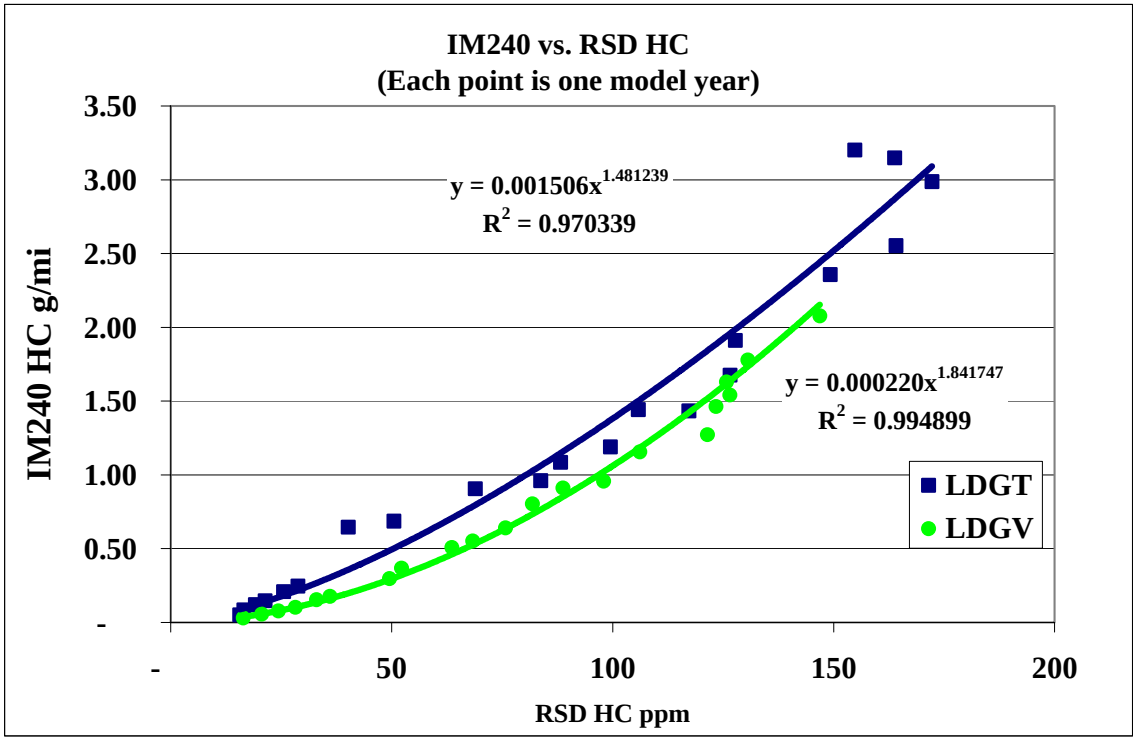
Table 4.2 St. Louis Enhanced Idle vs. RSD Correlation

RSD HC ppm = 2.3618 x (Enhanced Idle HC ppm)$^{0.7716}$
RSD CO % = 1.4197 x (Enhanced Idle CO %)$^{0.8514}$

2. IM240 Test Results vs. Remote Sensing Values

Figure 4.2 shows a similar plot of average IM240 HC emissions for each model year vs. the average on-road HC emissions. In this case, trucks (LDGT) have been separated from passenger vehicles (LDGV) because of the difference in the nature of the mass emissions measured by the IM240 test and the emissions concentrations measured by remote sensing. The mass of emissions produced for a given concentration depends in part on the weight and shape of the vehicle. Heavier, less aerodynamic trucks have higher mass emissions for a given concentration than lighter more streamlined passenger vehicles. This is reflected in the separation of the two trend lines.

Figure 4.2 IM240 vs. Remote Sensing HC



The correlation equations for HC and CO are shown in Table 4.3.

Table 4.3 IM240 vs. RSD Correlation

LDGV: IM240 HC gpm = 0.00022 x (RSD HC ppm)$^{1.84175}$
LDGT: IM240 HC gpm = 0.001506 x (RSD HC ppm)$^{1.48124}$
LDGV: IM240 CO gpm = 21.836 x (RSD CO %)$^{1.2086}$
LDGT: IM240 CO gpm = 23.872 x (RSD CO %)$^{1.0428}$

3. IM240 emissions vs. Idle emissions

The equations in Tables 4.2 and 4.3 are combined to yield the equations shown in Table 4.4 that are used to convert Idle test results to IM240 equivalent values.

Table 4.4 IM240 vs. Idle Correlation

LDGV: IM240 HC gpm = .001071 (Enhanced Idle HC ppm)$^{1.421094}$
LDGT: IM240 HC gpm = .005379 (Enhanced Idle HC ppm)$^{1.142925}$
LDGV: IM240 CO gpm = 33.352 (Enhanced Idle CO %)$^{1.0290}$
LDGT: IM240 CO gpm = 34.403 (Enhanced Idle CO %)$^{0.8878}$

G. St. Louis Fleet Composite Emissions Factors

The actual average emissions of the entire vehicle fleet are of interest because the MOBILE model calculates average emissions factors of the entire fleet. The emissions of exempt new vehicles and RapidScreen vehicles are weighted into the results from the tests conducted at St. Louis enhanced I/M stations to determine emissions factors for the total fleet.

A limited number of 2004 model vehicles and a larger number of 2003 model vehicles were tested at stations during calendar years 2002 and 2003. The average initial emissions of the 2003 model vehicles that were tested have been used to represent the emissions of new exempt vehicles. The number of new exempt vehicles in the St. Louis enhanced I/M area was estimated to be 129,273 per year[18].

A two percent random sample of vehicles qualifying for RapidScreen exemption are set aside for testing at stations. The average initial emissions from this random audit sample are used to represent the average emissions of the vehicles exempt from testing through the RapidScreen program. The number of unique vehicles obtaining a RapidScreen and no station tests in the two year period is 237,267. These were pro-rated between the St. Louis enhanced and basic I/M program areas to give a St. Louis enhanced I/M area estimate of 234,040 vehicles.

Table 4.5 summarizes the emissions factors of the vehicles comprising the St. Louis enhanced I/M fleet and calculates the VMT-weighted average tailpipe emissions. This table does not include non-exhaust HC emissions factors because the gas cap test data is not a test method that provides quantitative emissions results. Therefore, the initial and final gas cap test data cannot be compared.

[18] According to Missouri Department of Revenue Division of Motor Vehicle and Drivers Licensing registration data, 258,545 new gasoline-powered vehicles potentially subject to the emission inspection requirement were registered between January 2002 and December 2003. For the purposes of this program evaluation report, the registration data was assumed to be evenly distributed between these two calendar years.

Table 4.5 St. Louis Enhanced I/M Fleet Aggregated Emissions Factors

Test Type	Annual Miles	Unique Vehicles	Daily VMT ('M)	Initial IM240 g/mi HC	Initial IM240 g/mi CO	Initial IM240 g/mi NOx	Final IM240 g/mi HC	Final IM240 g/mi CO	Final IM240 g/mi NOx
Enhanced Idle	7,382	35,225	0.71	2.04	22.85	N/A	1.22	17.87	N/A
Enhanced IM240	10,343	687,124	19.47	0.55	5.95	1.25	0.40	4.19	1.14
OBD Clean Screen	14,287	219,240	8.58	0.10	1.37	0.45	0.10	1.37	0.45
RapidScreen	13,056	234,040	8.37	0.19	2.18	0.68	0.19	2.18	0.68
Exempt passenger	14,910	155,127	6.34	0.02	0.32	0.12	0.02	0.32	0.12
Exempt truck	19,863	103,418	5.63	0.04	0.59	0.20	0.04	0.59	0.20
Fleet Aggregate	12,497	1,434,175	49.10	0.30	3.41	0.74	0.23	2.64	0.69

H. Effect of Amended Waiver Requirements

The 2002 Program Evaluation Report stated that the balance between air quality and motorist convenience was in need of a small adjustment. The report recommended that the Gateway Clean Air Program reduce the number of waived vehicles to increase the air quality benefit of the St. Louis enhanced I/M program. Due in part to that analysis, more stringent waiver requirements were implemented on January 1, 2003. The amended St. Louis enhanced I/M waiver requirements increased the minimum spending amounts for all model years and required initially failed vehicles to demonstrate a reduction in the initially failing emissions without an increase in the initially passing emissions. These waiver requirements were designed to increase the air quality benefit, i.e., reduce the Gateway Clean Air Program composite emissions factors and bring them closer to the Enhanced I/M Performance Standard, without eliminating the convenience of the waiver option.

Table 4.6 compares the reductions from vehicles that received a waiver in 2002 under the previous waiver requirements with the reductions from vehicles that received a waiver in 2003 under the current waiver requirements.

Table 4.6 Waived Vehicle Average Emissions Factor Reductions by Calendar Year

Test Year	Type	Vehicles	First IM240 g/mi HC	First IM240 g/mi CO	First IM240 g/mi NOx	Last IM240 g/mi HC	Last IM240 g/mi CO	Last IM240 g/mi NOx	Reduction IM240 g/mi HC	Reduction IM240 g/mi CO	Reduction IM240 g/mi NOx
2002	P	10,567	3.00	34.15	2.96	2.65	30.31	2.77	0.35	3.84	0.19
2002	T	3,306	4.83	49.93	3.55	4.41	46.26	3.43	0.43	3.67	0.12
2002	All	13,873	3.44	37.91	3.10	3.07	34.11	2.93	0.37	3.80	0.17
								Total Reduction	**11%**	**10%**	**6%**
Test Year	**Type**	**Vehicles**	**First IM240 g/mi HC**	**First IM240 g/mi CO**	**First IM240 g/mi NOx**	**Last IM240 g/mi HC**	**Last IM240 g/mi CO**	**Last IM240 g/mi NOx**	**Reduction IM240 g/mi HC**	**Reduction IM240 g/mi CO**	**Reduction IM240 g/mi NOx**
2003	P	1,848	3.93	43.98	2.83	2.10	24.92	1.99	1.83	19.06	0.84
2003	T	479	6.48	66.85	3.13	3.89	46.45	2.47	2.59	20.40	0.66
2003	All	2,327	4.46	48.68	2.89	2.47	29.35	2.08	1.99	19.33	0.80
								Total Reduction	**45%**	**40%**	**28%**

By reducing the 2002 waiver rate of 25 percent of the initially failed vehicles by 80 percent, the Gateway Clean Air Program has caused more vehicles to be fully repaired, resulting in 11,546 fewer waived vehicles in 2003. Additionally, the 2,327 vehicles that received a waiver in 2003 have shown a substantial increase in their total emissions reductions when compared with the 13,873 vehicles that received a waiver in 2002. This change in waiver requirements is bringing the Gateway Clean Air Program closer to attaining the Enhanced I/M Performance Standard and closer to the desired balance between air quality benefits and motorist convenience.

I. St. Louis Enhanced I/M Emissions Reductions

Because the average initial and final composite exhaust emissions factors are available, the dynamic difference between the initial and final emissions factors represents the Gateway Clean Air Program air quality benefit in 2002 and 2003 on a fleet wide basis. Table 4.7 quantifies this reduction.

Table 4.7 2002-2003 St. Louis Enhanced I/M Fleet Average Emissions Factor Reductions

Pollutant	Difference (gpm)	Difference (%)
Exhaust HC	0.07	23.4 %
Exhaust CO	0.77	22.6 %
Exhaust NO_x	0.04	6.1 %

By comparing the initial aggregated fleet emissions factors in 2000 with the final aggregated fleet emissions factors in 2003, the cumulative effect of the St. Louis enhanced I/M program can be estimated[19]. Table 4.8 quantifies this reduction.

Table 4.8 2000-2003 St. Louis Enhanced I/M Fleet Average Emissions Factor Reductions

	2000 Initial IM240 (gpm) [20]	2003 Final IM240 (gpm) [21]	Difference (gpm)	Difference (%)
Exhaust HC	0.40	0.23	0.17	42.5 %
Exhaust CO	4.66	2.64	2.02	43.3 %
Exhaust NO_x	0.90	0.69	0.21	23.3 %

Based upon this Gateway Clean Air Program Test Data analysis, the St. Louis enhanced I/M program is effectively reducing the fleet wide average exhaust emissions factors.

[19] This estimation accounts for the fleet-wide average reduction in vehicle emissions from new model years of vehicles entering the St. Louis fleet, but does not account for the fleet-wide average increase in vehicle emissions from aging vehicles (deterioration).

[20] Table 4.5, Gateway Clean Air Program 2002 Program Evaluation Report.

[21] Table 4.5, Gateway Clean Air Program 2004 Program Evaluation Report.

V. Conclusions

Even though the MOBILE model and the Gateway Clean Air Program Test data analyses are not directly comparable, given the differences in their assumptions and methods of analysis, Table 5.1 lists the emissions factors generated by the MOBILE model version 6.2 Enhanced I/M Performance Standard scenario, listed in Table 3.1, and the calculated Gateway Clean Air Program Enhanced I/M Fleet Average emissions factors, listed in Table 4.5.

Table 5.1 MOBILE 6.2 and St. Louis Enhanced I/M Fleet Aggregated Emissions Factors

Pollutant	MOBILE 6.2 Enhanced I/M Performance Standard (gpm)	Enhanced I/M Fleet Average Emissions Factors (gpm)
Exhaust HC	0.510	0.23
Exhaust CO	10.87	2.64
Exhaust NO_x	0.983	0.69

A. MOBILE Model Data Conclusions

Based upon the MOBILE model version 6.2 analysis provided, the St. Louis enhanced I/M element has exceeded the Basic I/M Performance Standard and is very close to meeting the Enhanced I/M Performance Standard.

B. Gateway Clean Air Program Test Data Conclusions

Based upon the Gateway Clean Air Program test data analysis provided, the Gateway Clean Air Program is effectively reducing the tailpipe VOC, CO, and NO_x emissions of light duty gasoline-powered vehicles and trucks. Because the Gateway Clean Air Program is also testing gas caps, the Gateway Clean Air Program is also reducing the evaporative VOC emissions of light duty gasoline-powered vehicles and trucks, although the effectiveness of this reduction is not quantified in this report.

C. Program Evaluation Report Recommendations

Based upon the entire report, the department recommends that EPA Region VII continue to designate the St. Louis enhanced I/M program as a federally-approved I/M program and find the I/M portion of the Missouri SIP approvable.